



**The Valorisation of Human Capital
as a Key Element
of Competitiveness.
The “Trust Game Corporation”
Perspective**

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CSR PAPER 4.2006

DECEMBER 2006

CSRM – Corporate Social Responsibility and Sustainable Management
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CORE is financed by the European Commission, Sixth Framework Programme and it is co-ordinated by Fondazione Eni Enrico Mattei (FEEM).

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The Valorisation of Human Capital as a Key Element of Competitiveness. The "Trust Game Corporation" Perspective

Summary

We conceive firm productive activity as being crucially determined by the performance of complex tasks which possess the characteristics of trust games. We show that in trust games with superadditivity the non cooperative solution yielding a suboptimal firm output is the Subgame Perfect Nash Equilibrium (SPNE) of the uniperiodal full information game when i) the trustor has superior stand alone contribution to output and ii) the superadditive component is inferior to the sum of trustee and trustor stand alone contributions to output. We show that, if relational preferences of the two players are sufficiently high, the result is reversed. We also document that the Folk Theorem applies to the infinitely repeated game, even in absence of relational preferences, but the enforceable cooperative equilibrium is not renegotiation proof. We finally show that the cooperative equilibrium is not attainable under single winner tournament schemes and that steeper pay for performance schemes may crowd out information sharing in presence of players preferences for relational goods. Our findings help to explain why firms are reluctant to use pay for performance and tournament incentive schemes and why they invest money to increase the quality of relational goods among employees.

Keywords: Trust Game, Work Incentives, Folk Theorem

JEL classification: C7, M14, M5, L29

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1 Introduction

When we conceive the corporate workforce as being composed by self interested individuals maximising consumption under standard budget constraints in a framework of asymmetric information with moral hazard, it becomes hard to explain why contemporary firms invest money to increase the quality of relationships among workers inside and outside the workplace² and why pay for performance schemes are relatively less and team compensation schemes are relatively more widespread than expected (Baker, Jensen and Murphy, 1988; Baker, Gibbons and Murphy, 2002)³.

In this paper we try to explain these two apparent puzzles by introducing some changes in the way we conceive firms and by arguing that: i) an essential trait of contemporary firms is that their activity crucially depends on the realisation of complex tasks which require the combination of nonoverlapping skills of several workers and possess the intrinsic characteristics of trust games with superadditivity; ii) individuals have relational preferences

"Mattei" in Milan and at the 2006 workshop on "CSR and corporate governance" of the International Economic Association. The authors thank Luciano Andreozzi, Masahiko Aoki, Avner Ben Ner, Bruce Chapman, Allen Kaufman, Bruno Frey, Lorenzo Sacconi, Margit Osterloh, Alessandro Vercelli, Oliver Williamson and all other participants to these conferences for their comments and suggestions. Special thanks to Annalisa Luporini for her precious suggestions. The usual disclaimer applies.

²One of the biggest Italian banks, Mediobanca, finances weekend skydiving holidays to their management with the motivation that it makes the business more fluid. In the U.S., the NRG Systems, a global manufacturer of wind measuring systems, received the 2004 Psychologically Healthy Workplace Award for small businesses from the Vermont Psychological Association (VPA) thanks to their overall workforce practices and benefits and the emphasis they have placed on creating a healthy workplace.

³Empirical evidence shows that profit sharing plans are quite popular. In 1988, 20 percent of the US labor force (22 million employees) participated in over 400,000 workplace profit-sharing plans. The number of profit-sharing pension plans has increased by 19,000 per year since 1970. Lawler (1971, p. 158) quotes six different works on the relationship between pay and performance, and finds that "their evidence indicates that pay is not very closely related to performance in many organizations that claim to have merit increase salary systems. The studies suggest that many business organizations do not do a very good job of tying pay to performance. This conclusion is rather surprising in light of many companies very frequent claims that their pay systems are based on merit." Frey (1997) adds that pay for performance is much less used for middle-level employees than for workers employed in repetitive activities since the latter have lower intrinsic motivations and therefore crowding out effects are reduced.

(i.e. a taste for quality of relationships) with working colleagues⁴.

By introducing these two elements we are able to show under different versions (uniperial, infinitely repeated, with perfect or imperfect information) of our basic corporate trust game that lower quality of relational goods, individual pay for performance schemes and (single winner) tournament incentive structures significantly widen the parametric space of non-cooperative⁵ equilibria which, in turn, reduce the circulation of knowledge and the interaction of different competencies, yielding suboptimal output for the firm.

Our theoretical framework introduces some elements which are original (in themselves or in the way they are combined in the model) in the literature. First, it refers to relational preferences which are closely related to, but also represent a slight departure from the more traditional and established field of studies on reciprocity. Fehr and Gächter (2000) show that reciprocity is an important determinant in the enforcement of contracts. More specifically, reciprocity may render the provision of explicit incentives inefficient because the latter may enhance a non-cooperative behaviour⁶. The hypothesis that reciprocity plays a role in determining effort for a significant part of workers has been successfully tested in several laboratory experiments (Fehr, Gächter and Kirchsteiger, 1997; Fehr and Gächter, 2000; Bewley, 1995)⁷. The concept of relational goods (Ash, 2000) that we introduce is

⁴To provide empirical evidence on this second point we report in the Appendix 1 econometric findings showing how the time spent with working colleagues outside the workplace has positive effects on individual's happiness.

⁵Note that we define as *cooperative solution* in the paper the equilibrium given by the (share, not abuse) pair of strategies (see Figure 1, Appendix 2) and as *non cooperative solutions* the two equilibria which do not imply the joint work of the two players. Hence, the term cooperative is not referred to the structure of the game (or to the coordination/noncoordination of players decisions) but to the characteristics of its equilibrium.

⁶The employment relationship may be characterized by complete or incomplete contracts. Under complete contracts a cooperative job attitude would be superfluous because all relevant actions would be described and enforceable, while, under incomplete contracts, workers have a high degree of discretion over effort levels since no explicit performance incentives are defined. In this case reciprocity can be very important in the labor process since, if a substantial fraction of the work force is motivated by reciprocity considerations, employers can affect the degree of cooperation by varying the generosity of the compensation package.

⁷A crucial question in this field is to understand how material incentives based on performance interact with reciprocity. Following Fehr and Gächter (2000) two main aspects have to be taken into account: i) reciprocity increases the extra effort determined by ma-

slightly different from that of reciprocity and may help to shed light on the interaction between material incentives and productivity. According to Uhlaner (1989) and Gui (2000) relational goods are local public goods that need i) to be jointly co-produced and ii) to be simultaneously co-consumed to be enjoyed ⁸ While a sufficient condition for reciprocity is the feeling of the obligation to reciprocate what has been received by a counterpart and, therefore, a general sense of justice, relational values are more related to the pleasure that individuals have in spending time with other human beings. In support of the relational good approach and of its importance in the jobplace, Frey (1997) argues that more personal relationships imply recognition, trust and loyalty which support intrinsic motivation. Hence, our point is that the focus on the dynamics of relational goods does not exactly coincide, but is at the root of the widely analysed phenomena of trust, reciprocity and intrinsic motivation, since the latter tend to be based not only on abstract principles or on a Kantian sense of duty, but also on the quality of relationships. In our paper an original virtuous link between relational goods and productivity is identified within the structure of the "trust game corporation". *In the corporate trust game relational goods increase the penalty for a noncooperative attitude (represented by the loss of the accumulated relational stock) and therefore reduce the parametric space of noncooperative equilibria which are suboptimal on the productive point of view.* We therefore identify a positive nexus which goes from the quality of workers relationships to the willingness to share information and cooperate and, from the latter, to firm productivity. A second novelty of the paper is that it applies the standard trust game approach to the literature of the organisation of the firm. As it is well known, there is ample experimen-

terial incentives and ii) explicit incentives may cause a hostile atmosphere of threat and distrust which reduces any reciprocity-based extra effort.

⁸Standard microeconomic foundations of agents utility usually neglect the fact that the latter does not depend only on the amount of consumed goods but also, at least, on the relational context in which material goods are consumed (eating a pizza alone is not the same as eating a pizza with friends or with the love partner). Going back to the history of economic thought, one of the nicest and deepest interpretations of the link between social ties and happiness is provided by Adam Smith (1759) with its well known theory of fellow feelings. In the *Theory of moral sentiments* Smith argues that the effect of relational goods on happiness is increasing in i) the amount of time and experiences that two individuals have lived together and have shared in the past and ii) their common consent, with the former significantly affecting the latter.

tal literature showing that predictions from standard noncooperative game theory do not apply to large part of two-person trust games (McCabe et al., 2003; Berg, et al., 1995; McCabe et al., 1998; Ben Ner and Putterman, 2006). There is no literature, to our knowledge, studying consequences of trust games among co-workers. Consider also that there exist some crucial differences stemming from the necessarily different assumptions between our corporate trust game and the above mentioned (non corporate) experimental trust games. In the standard Berg, et al. (1995) trust game, extended by Ben Ner and Putterman (2006), the trustee can arbitrarily decide how much output to give back to the trustor. Furthermore, situations similar to the pay for performance schemes described in section 3.1 where the trustee decision not to abuse implies a specific penalty (loss of part of his pay for performance fee) have not been tested.

The motivation behind our decision to model the productive activity of the firm as a corporate trust game arises from the fact that, when we depart from the assembly line perspective and move toward a firm in which workers skills are fundamental to create value and innovate products and processes, corporate activity becomes more complex and requires the sharing and interaction of different nonoverlapping competencies and information⁹. Third, the paper fills a gap in the theory of the firm by introducing additional elements which help to reconcile theoretical models with the above mentioned empirical evidence on the (lower than expected) diffusion of individual pay for performance schemes¹⁰ and the (higher than expected) diffusion of profit sharing or team compensation schemes, especially when we focus on non manual worker (Frey, 1977; Baker, Jensen and Murphy, 1998; Baker, Gibbons and Murphy, 2002). This evidence is difficult to reconcile with the standard theory of the firm and with the traditional argument in the litera-

⁹Thompson and Wallace (1996) argue that, with the development of lean production and other forms of work organization under advanced manufacturing, teamworking has emerged as a central focus of redesigning production. Katz and Rosemberg (2004) argue that that the productivity of an organization crucially depends on cooperation between workers and highlight the importance of altruistic and cooperative attributes in workers emphasized by the organizational theory (see, for example, Smith et al. (1983), Organ (1988), Organ and Ryan (1995), McNeely and Meglino (1994), Penner et al, (1997) and Podsakoff and Mackenzie (1993)).

¹⁰Baker et al. (1998) argue that when measures of individual performance are available, it always seems better to tie pay to individual performance rather than to overall firm performance.

ture that tournament schemes may raise performance when the disciplining effect, as it is conventionally assumed, is larger than the crowding-out effect of intrinsic motivation (Lazear and Rosen, 1981). Some of the rationales advanced to explain this puzzle come from psychologists and behaviorists. Deci and Ryan (1985) identify a trade-off between monetary compensation and intrinsic rewards¹¹. Slater (1980) argues that money as a motivator has negative effects on product quality. Kohn (1988) argues that monetary rewards encourage people to focus narrowly on a task, to do it as quickly as possible, and to take few risks. Other potential explanations for this puzzle are horizontal equity concerns, and imperfect performance measurement¹². *In our model we show that the conception of firm activity as a series of trust games in which different tasks and information from various individuals are combined may be, under reasonable parametric assumptions, a sufficient condition for determining the relative inconvenience of single winner tournament schemes even without considering the crowding out effect on intrinsic motivations and, therefore, purely on extrinsic motivation grounds. We also show that the presence of relational goods introduces a specific crowding out effect of pay for performance schemes on cooperation.*

The paper derives the above mentioned considerations from a theoretical model and is divided into six sections (introduction and conclusions included). In the second section we examine the uniperiodal and the infinitely repeated full information games (with and without the presence of relational goods) when the two players own the company. In the third section we look for Bayesian equilibria under the assumption of players' uncertainty on skills and relational attitudes of their counterparts. In the fourth section we find equilibria for the corporate trust game when players are firm employees and pay for performance and tournament schemes are introduced. In the fifth section we briefly illustrate the optimal corporate policy for trust game corporations.

¹¹The crowding out hypothesis relies on the assumption that, if workers are already intrinsically motivated, an extrinsic reward overmotivates them and therefore they rationally react by reducing the motivation which is under their control (i.e. the intrinsic motivation).

¹²On the role of intrinsic motivation on the behaviour of economic agents see, among others, Frey (1997) and Kreps (1997).

2 The basic trust game when the players own the company

We assume that the productive activity of a firm originates from the performance of complex tasks¹³ which require the contribution of knowledge, inventive skills and ideas of workers with (partially) nonoverlapping human capital endowments. In our specific case we assume that any complex task consists of a trust game between two firm employees, player A and B, endowed with personal skills (stand alone contributions to final output) that we term, respectively, as $h_a \in R^+$ and $h_b \in R^+$. The trust game is a sequential game in which one of the two players (player A, the trustor) may decide whether sharing or not his skills with the other player. In the second stage of the game the second player (player B, the trustee) may decide to cooperate or abuse. We assume in the model that sharing ideas, projects, intuitions creates a positive externality - that we introduce in the model as a superadditive component ($e \in [0, \infty]$) - generated by the dialogical process of jointly performing the task and by the initial knowledge sharing (Figure 1, Appendix 2)¹⁴.

Summing up the set of strategies available to the two players, player A (the trustor) may decide to share (s strategy) or not to share (ns strategy) his initial ideas to the trustee who, in turn, may decide to abuse (a strategy) or not (na strategy). If the trustee decides to abuse he will join his ideas with those of the trustor and present everything as his own work, while, if he decides to share, the two players will interact and produce as additional contribution to the output a superadditive component e stemming from the integration of players perspectives, to which new ideas arising from the interaction also contribute. We assume in this case that the final output is

¹³Consider for instance a blueprint in which different contributors skills are production inputs related by some forms of complementarity. Or the definition of a corporate strategy which requires participants from different firm divisions to share knowledge and skills. The same scheme could be applied in different (non corporate) fields of activity considering, for instance, a co-authored academic working paper to which different researchers contribute with their specialised skills.

¹⁴Our point here is that dialogue, interaction and information sharing is indispensable to the act of cognition which improves productive knowledge. In particular, superadditivity implies that i) part of productive skills may be acquired only by integrating experiences of different people ii) learning is a process which can be enhanced by explaining and confronting ones own knowledge with that of a workmate.

split between the two players. Under these assumptions the set of payoffs (player A, player B and firm output) are:

$\{(0 \mid h_a < h_b, h_a \mid h_a > h_b), (0 \mid h_a > h_b, h_b \mid h_a < h_b), \text{Max}(h_a, h_b)\}^{15}$ if player A does not share;
 $\{0, h_a + h_b, h_a + h_b\}^{16}$ if player A shares but player B chooses to abuse;
 $\{(h_a + h_b + e)/2, (h_a + h_b + e)/2, h_a + h_b + e\}$, if player A shares and player B cooperates.

The game is represented in the extensive form in Figure 1 (see Appendix 2). The analysis of the uniperiodal trust game leads us to formulate the following proposition

Proposition 1. The non sharing solution yielding a suboptimal firm output is the SPNE of the uniperiodal full information game when i) the trustor has higher stand alone contribution to output than the trustee and ii) the superadditive component is inferior to the sum of trustee and trustor stand alone contributions.

When $h_a > h_b$, players A payoff is h_a if he does not cooperate and 0 if he decides to cooperate but player B abuses, as he will do when $h_a + h_b > (h_a + h_b + e)/2$, or, $e < h_a + h_b$. Hence, if $h_a > h_b$ and $e < h_a + h_b$, the non sharing solution is the SPNE of the uniperiodal full information game¹⁷. Consider that the SPNE yields a firm output - $\text{Max}(h_a, h_b)$ which is lower than the one achievable under cooperation ($h_a + h_b + e$), and even lower than that obtainable under the (share, abuse) pair of strategies¹⁸. The loss

¹⁵The assumption here is that some authority external to the two players will pick up the best individual blueprint. We may imagine that, in a competition for a project, the two players, when not agreeing to cooperate, decide to participate separately to the competition.

¹⁶The assumption here is that the two players competencies and skills do not overlap. If they do, the total output of player B in the (s, a) solution and the one shared by the two players in the (s, na) solution should be the non overlapping part of the sum of the two stand alone contributions. A second assumption is that the trustee has sufficient skills to be able to manage the contribution provided by the trustor and therefore to abuse of it.

¹⁷Two consequences of the SPNE of the game which are intuitively reasonable are that: i) the trustor's decision to share crucially depends on the knowledge that his stand alone contribution to output is lower than that of the trustee; ii) the likelihood of the occurrence of the (share, not abuse) solution is higher when the two players' stand alone contributions are small with respect to the output they can generate by applying together to the problem (i.e. the task has complex rules that can be interpreted only by combining players skills).

¹⁸We reasonably assume that, when player B abuses, he exploits player A information for his own project before starting the cooperative process of jointly performing the task and, therefore, $e=0$.

of social surplus (and of firm productive potential) therefore amounts to $h_a + h_b + e - \text{Max}(h_a, h_b)$. If, on the contrary, $h_a < h_b$ and $e < h_a + h_b$, player A is indifferent between the two available strategies (share and do not share), since the payoff that he will receive is the same in both cases. In such case the SPNE equilibrium can alternatively be represented by the following strategy pairs, (ns,.) or (s,a), yielding again a suboptimal firm output with a social loss, respectively, equal to $h_a + h_b + e - \text{Max}(h_a, h_b)$ or e ¹⁹. \square

To sum up, the full information uniperiodal game shows that, when the trustors stand alone contribution is higher, the subgame perfect equilibrium is a non information sharing solution and the firm output is inferior to its maximum potential. Under the alternative assumption on the relative human capital endowments of the two players we have two possible solutions. Both of them do not imply information sharing and still yield a suboptimal firm output.

A graphic representation of the cooperation area is provided in Graphic 1 (in Appendix 2) in which the superadditivity component is on the horizontal axis, the trustor stand alone contribution is on the vertical axis and the trustee stand alone contribution is fixed. The area of information sharing equilibria is the one, below the fixed level of trustee stand alone contribution, in which $e > h_a + h_b$

2.1 The basic one period trust game when players own the company with relational goods

In the basic version of the model presented in section 2 we did not take into account the role of relational goods. As already mentioned in the introduction, more personal relationships imply recognition, trust and loyalty which support intrinsic motivation (Frey, 1997). Relational preferences (and the enjoyment of relational goods) are therefore one of the fundamental inputs of trust and reciprocity. Their introduction into players preferences needs to be motivated. In the Appendix 1 we provide empirical evidence which supports our choice showing that, in a sample of more than 100,000 indi-

¹⁹Note that the trustor would strictly prefer the (ns,.) solution if we add some forms of inequity aversion to the model.

viduals from 82 countries drawn from the World Value Survey database, the time spent with job friends outside the workplace significantly increases the probability of declaring oneself very happy, net of the effect of standard controls traditionally used in the empirical happiness literature.

In this section we assume that the two players have a stock of accumulated relational goods equal to (F) which depends on the number of times they have cooperated in the past and may jointly produce a relational good (f) with their decision to cooperate. The solution of the uniperiodal game with relational goods leads us to formulate the following proposition

Proposition 2. In the uniperiodal full information game, when $(h_a + h_b - e)/2 > F$, there exists a threshold value of the relational good in the trustee utility function (f^) which triggers the switch from the non cooperative to the cooperative (share, not abuse) equilibrium.*

In presence of relational goods the payoff set (player A and player B payoffs and firm output) becomes:

$$\{(F \mid h_a < h_b, F+h_a \mid h_a > h_b), (F \mid h_a > h_b, F+h_b \mid h_a < h_b), \text{Max}(h_a, h_b)\}$$

if player A does not share;

$\{0, h_a + h_b, h_a + h_b\}$, if player A shares but player B chooses to abuse;

$\{(h_a + h_b + e)/2 + F + f, (h_a + h_b + e)/2 + F + f, h_a + h_b + e\}$, if player A shares and player B does not abuse (Figure 2, Appendix 2).²⁰

If $h_a > h_b$, the subgame perfect equilibrium of the full information uniperiodal game is $(ns, .)$ On the other hand, if $h_b > h_a$, player B chooses to abuse when $h_a + h_b > e + 2(F + f)$ (which represents the new abuse condition in presence of value of relational goods). Again, the non cooperative solution yields a firm output, $\text{Max}(h_a, h_b)$, which is lower than $h_a + h_b + e$ (that is, firm output under the (s, na) equilibrium) and lower than that obtained under the (s, a) solution. Hence, given the new abuse condition, if $(h_a + h_b - e)/2 > F$, we may identify a threshold (f^*) in the value of the relational goods for the trustee above which the (share, not abuse) couple

²⁰Our underlying assumption is that the accumulated stock of relational goods between the two players may be lost only when one of the two decides to abuse and not when he decides not to share. Under this condition, in presence of relational goods, the trustor will not be indifferent anymore between sharing or not when $h_a < h_b$ and the no abuse condition is not met since, by sharing, he will induce into temptation the other part with the risk of loosing the accumulated stock of relational goods. Hence, if $F > 0$ and $h_a < h_b$, the $(ns, .)$ strategy is strictly preferred. Under this case the firm output is always suboptimal but may be inferior in presence of relational goods.

of strategies becomes the SPNE of the single period full information game. Such threshold is equal to $f^* = (h_a + h_b - e)/2 - F$. \square

By examining now the abuse condition we observe that the incentive to abuse is reduced because of the potential loss of the stock of relational goods and the missed production of new relational goods in case of non cooperation (see Figure 2). The introduction of relational goods therefore identifies a virtuous circle among quality of workers relationship, decision to cooperate (which further increases the quality of relationships) and firm productivity, or among relational goods, social capital (under the form of trust) and firm productivity (see Graphic 2 and Figure 2).

It is easy to check that, a finite (two) period trust game has the same characteristics of the single period one since, when the no abuse condition is not met, with backward induction the trustor will anticipate the trustee abuse in the second period and will decide not to share in both periods (solutions of this game are omitted for reasons of space and available upon request).

2.2 The infinitely repeated game

The analysis of the infinitely repeated version of the game without relational goods leads us to formulate the following proposition

Proposition 2. In the full information infinitely repeated trust game, the (share, no abuse) equilibrium may be applied without the need of relational goods for reasonable discount rates, but it may never hold, under given parametric conditions, when the trustee has higher stand alone contribution than the trustor. Even when the (share, not abuse) equilibrium applies, it is however based on a trustor threat which is not renegotiation proof.

The Folk Theorem applies to the infinitely repeated game if there exists a $\delta \in [0, 1]$ ²¹ such that the (share, not abuse) equilibrium is enforceable. By applying it to this modified version of the game we get $(1 - \delta)(h_a + h_b) = (h_a + h_b + e)/2$, if $h_a > h_b$, and $(1 - \tilde{\delta})(h_a + h_b) + \tilde{\delta}h_b = (h_a + h_b + e)/2$, if $h_a < h_b$. If $h_a > h_b$, $\tilde{\delta} = 1/2 - e/[2(h_a + h_b)]$, which is below 1

²¹As it is well known δ is the inverse of the subjective discount rate or the standard measure of players patience. Consider that higher values of δ can also be viewed as a measure of the reduced distance between two consecutive stages of the game.

for reasonable parametric values. On the other hand, if $h_b > h_a$, $\tilde{\delta} = 1/2 + (1/2)(h_b/h_a) - e/h_a$. Under reasonable parametric conditions - and, more specifically, when $[(h_b - h_a)/2] < e$ we get $\tilde{\delta} > 1$ and the cooperative equilibrium may not be enforced. The renegotiation argument applies here. Consider that the punishment strategy costs any period to the trustor $(h_a + h_b + e)/2$, if $h_a < h_b$, and $(h_a + h_b + e)/2 - h_a$ if $h_a > h_b$. Hence, the trustee may propose, after abusing in the first period, a preliminary side payment of ε , when $h_a < h_b$, or $h_a + \varepsilon$, when $h_a > h_b$, conditional to the trustor's commitment to share in the following period. The trustor should strictly prefer the new proposal which may be repeated an infinite number of times after any abuse by the trustee. Hence, we get $(1 - \tilde{\delta})(h_a + h_b) + \tilde{\delta}(h_a + h_b - \varepsilon) = (h_a + h_b + e)/2$, if $h_a < h_b$, and $(1 - \tilde{\delta})(h_a + h_b) + \tilde{\delta}(h_b + \varepsilon) = (h_a + h_b + e)/2$, if $h_a > h_b$. It is easy to check that, in both cases, and especially when $h_a < h_b$, $\tilde{\delta} > 1$ under reasonable parametric conditions. \square

Notice that the Folk Theorem condition under $h_a > h_b$ implies that the minimum trustee patience required to have a cooperation equilibrium is negatively related to the ratio between the superadditive component and the sum of the two players stand alone contributions. The intuition is that the superadditive component is what players loose when they decide not to cooperate. If the loss is high, a cooperative equilibrium can be enforced also when the trustee has limited patience. When, on the contrary, $h_b > h_a$ the Folk Theorem condition implies that the minimum trustee patience required to have a cooperation equilibrium is higher and depends positively from the trustee stand alone contribution and negatively from the superadditive component and trustor stand alone contribution which are part of the punishment in case of abuse.

3 The trust game with imperfect information

We have assumed so far that players are perfectly informed about game payoffs and each other skills. More realistically, corporate trust game players have to deal with an incomplete information framework. We reasonably argue that informational asymmetry in the corporate trust game may be related to: i) the relational attitude of the other player, that is, the presence in his utility function of a positive argument related to the cooperation

with his colleague; ii) the stand alone contribution to output of the other player. In this version of the model we deal with the first type of imperfect information. The assumption of imperfect knowledge of the counterpart relational attitudes obviously implies that the two players have not enjoyed cooperation before and, therefore, that $F = 0$. More specifically, we assume that each player attaches a probability $p \in [0, 1]$ to the likelihood that his counterpart gives a value f to the relational good produced by the cooperative working activity (see Figure 3, Appendix 3). The modified framework of the game leads us to formulate the following proposition

Proposition 3. The trustor imperfect information about the trustee's relational preferences raises the threshold value of the relational good required to ensure the (share, not abuse) equilibrium.

If each player attaches a probability p to the likelihood that his counterpart gives a value f to the relational good produced by the cooperative working activity the no abuse condition becomes $2pf + e > h_a + h_b$. Hence, the Bayesian NE of the game is: i) $(ns, .)$ if $p(e + 2f) + (1 - p)e < h_a + h_b$ and $h_a > h_b$; ii) $(ns, .)$ or (s, a) if $p(e + 2f) + (1 - p)e < h_a + h_b$ and $h_a < h_b$; iii) (s, na) if $p(e + 2f) + (1 - p)e > h_a + h_b$. Considering the three different solutions, we assume that a threshold probability value p^* exists, such that, when $p > p^*$, the (share, not abuse) pair of strategies becomes the NE of the game. We can obtain p^* as $p^* = (h_a + h_b + e)/2f$. For $p^* < 1$ we need $f > [(h_a + h_b + e)/2]/p^*$. This implies a threshold value of the relational good under uncertainty which is higher than its certainty correspondent (in which $p = 1$). \square

This result shows that the no abuse condition with incomplete information is respected only if the relational good produced by the interaction of the two players is big enough to compensate the cost of the uncertainty about the counterpart relational attitude (see Figure 4, Appendix 2). Let us consider a second case of imperfect information related to the counterpart stand alone contribution. We assume here that player A assigns a subjective probability p_1 ($p_1 \in [0, 1]$) to the $h_a > h_b$ hypothesis, while player B a subjective probability p_2 , ($p_2 \in [0, 1]$) to the alternative $h_a < h_b$ hypothesis (see Figure 4). We also assume that each player does not know the guess of the other. The inspection of the corporate trust game which incorporates these new assumptions leads us to formulate the following proposition

Proposition 4. In presence of imperfect information on the counterpart stand

alone contribution, the non sharing solution yielding a suboptimal firm output is the SPNE of the uniperiodal full information game when the super-additive component is inferior to the sum of the trustee and trustor stand alone contributions to output (the no abuse condition is unaltered with respect to the full information model) but the superiority of the trustee stand alone contribution is no more required for the uniqueness of the (ns,.) equilibrium.

It is easy to check that as in the previous case, the no abuse condition is $e > h_a + h_b$, exactly the same as in the full information uniperiodal game.

For the second part of the proposition consider that, with $p_1 > 0$, when the no abuse condition is not met, the trustor will always choose the (ns,.) equilibrium²².□

The intuition for the first part of this proposition is obvious. The no abuse condition compares two trustees payoffs (conditional to the abuse and not abuse strategies respectively) under the assumption that the trustor has decided to share information. In both cases the trustee payoff includes the sum of the two players contributions and therefore the relative superiority of one of the two stand alone contributions does not matter. The second result of this proposition depends on the fact that, under imperfect information on counterpart's skills, each player always attaches a nonzero probability to the fact that his skills may be superior to those of the other player.

4 Basic Trust Game when the Players do not own the Company

We now examine how equilibria change when we remove the assumption that the two players own the company. In this version of our model we show that the conception of firm activity as a series of trust games in which different tasks and information from various individuals are combined may be, under reasonable side assumptions, a sufficient condition for determining the relative inconvenience of single winner tournaments (or pay for perfor-

²²Hence, when player stand alone contribution is imperfectly known by the counterpart, the paradoxical case (see footnote 20) in which relational goods may induce a lower output when the no abuse condition is not met ($Max[h_a, h_b]$ instead of $h_a + h_b$) does not apply anymore, since this outcome occurs even without relational goods.

mance schemes in presence of workers taste for relational goods). This result holds without considering the crowding out effect on intrinsic motivations and, therefore, purely on extrinsic motivation grounds. We in fact show that: i) when the activity of a firm is conceived as a trust game and, in presence of relational goods, a steeper pay for performance scheme increases the probability of non cooperative equilibria for given parametric values ; ii) the cooperative equilibrium can never be attained with the introduction of a single winner tournament scheme, even in absence of relational goods.

4.1 Pay for performance schemes

We start by considering a simple pay-for-performance structure, consisting of a fixed remuneration (w_a for player A, and w_b for player B) plus an additional share $s \in [0, 1]$ of the employees performance when it contributes to firm output. The inspection of the uniperiodal and infinitely repeated games under the new framework leads us to formulate the following proposition

Proposition 5. Individual pay for performance schemes are neutral in corporate trust games in which players do not own the firm, as they do not help to widen the parametric space of the cooperative equilibrium. In presence of relational goods pay for performance schemes crowd out cooperation since a steeper pay for performance scheme may trigger the switch from a cooperative (productively optimal) to a non cooperative (productively suboptimal) equilibrium. Hence, pay for performance schemes crowd out cooperation.

Under the pay for performance scheme framework the set of payoffs is

$$\{w_a + s(h_a \mid h_a > h_b, 0 \mid h_a < h_b), w_b + s(h_b \mid h_a < h_b, 0 \mid h_a > h_b), (1 - s)[Max(h_a, h_b)] - w_a + w_b\}$$

under the (ns,.) pair of strategies, while it is

$$\{w_a, w_b + s(h_a + h_b), (1 - s)(h_a + h_b) - w_a + w_b\} \text{ and } \{w_a + s(h_a + h_b + e)/2, w_b + s(h_a + h_b + e)/2, (1 - s)(h_a + h_b + e) - w_a + w_b\}$$

under the (s,a) and (s,na) pairs, respectively (see Figure 5).

It is easy to check in this case that the no abuse condition ($e > h_a + h_b$) corresponds to the no abuse condition of the full information game when players own the company. Let us evaluate the effect of relational goods in this framework. The payoff set under the (ns,.) (s,a) and (s,na) pairs becomes respectively $\{F + w_a + s(h_a \mid h_a > h_b, 0 \mid h_a < h_b), F + w_b + s(h_b \mid h_b > h_a, 0 \mid h_b < h_a), (1 - s)[Max(h_a, h_b)] - w_a + w_b\}$

$\{w_a, w_b + s(h_a + h_b), h_a + h_b\}$ and
 $\{F + f + w_a + s(h_a + h_b + e)/2, F + f + w_b + s(h_a + h_b + e)/2, (1 - s)(h_a + h_b + e) - w_a + w_b\}$ (Figure 8).

The no abuse condition in this case is $e > h_a + h_b - 2(F + f)/s$ and does not correspond anymore to the one of the full information game in which players own the company \square .

Note that, with $s = 1$, we revert to the situation in which players own the company but, as far as s gets lower (and the pay for performance scheme gets flatter), the effect that preferences and enjoyment of relational goods have on making the no abuse condition easier to be met are enhanced. This result shows that, given the simple structure of corporate trust games, pay for performance schemes crowd out quality of relationship and trust and provides a simple rationale to the puzzle evidenced, among others, by Baker, Jensen and Murphy (1998) on the relatively low use of individual pay for performance schemes in personnel management. It implies that a steeper reward scheme (s) may trigger the switch from the cooperative (s, na) to the non cooperative solutions of the game. The intuition is that (s) becomes the relative price of the relational goods in terms of missed outperformance arising from the abuse strategy and this relative price rises as far as the share gets higher.

The inspection of this specific version of the game repeated in time confirms the main finding of the uniperiodal game and leads us to formulate the following proposition.

Proposition 6. In the two period and in the infinitely repeated trust game when the two players do not own the firm, steeper individual pay for performance schemes are neutral in absence of relational goods, while they reduce the parametric space of cooperation in presence of relational goods .

Let us start with the two period game without relational goods (Figure 5, Appendix 2). The solution crucially depends again from the relative stand alone contributions. When we assume $h_a > h_b$ the no abuse condition is $[w_b + s(h_a + h_b + e)/2](1 + \delta) > w_b + s(h_a + h_b) + \delta w_b$ ²³

Consider that, here again, the no abuse condition does not depend on s and reduces to that of the two period model when the two players own the firm. Furthermore, the no abuse condition requires that $\delta > 1 - e/(h_a + h_b)$, which

²³Note that, with $s = 1$ and $\delta = 0$, we revert to the no abuse condition of the full information single period game of section 2, while, with $s = 0$ and $\delta = 0$, to a single period fixed wage model.

may be easily satisfied under reasonable parametric assumptions.

Let us suppose now that $h_a < h_b$. In this case, the no abuse condition is $[w_b + s(h_a + h_b + e)/2](1 + \delta) > w_b + s(h_a + h_b) + \delta(w_b + sh_b)$ which reduces, again, to $e > h_a + h_b$, that is, the no abuse condition of single period full information game when the two players own the firm. Consider now the presence of relational goods in the two period game (Figure 10). Under $h_a > h_b$ the no abuse condition is $w_b + s(h_a + h_b) + \delta w_b < F + [f + w_b + s(h_a + h_b + e)/2](1 + \delta)$ yielding $\delta > [s(h_a + h_b - e) - 2F - 2f]/[2f + s(h_a + h_b + e)]$. Under $h_a < h_b$ the no abuse condition is $w_b + s(h_a + h_b) + \delta(w_b + sh_b) < F + [f + w_b + s(h_a + h_b + e)/2](1 + \delta)$ yielding $\delta > [s(h_a + h_b - e) - 2F - 2f]/[2f + s(h_a - h_b + e)]$. Hence we conclude that, even in the two period game, steeper pay for performance schemes are neutral in absence of relational goods, while they reduce the parametric space of cooperation in presence of relational goods. In the same way, in an infinitely repeated game in absence of relational goods, and, when $h_a > h_b$, we have $(1 - \tilde{\delta})[w_b + s(h_a + h_b)] + \tilde{\delta}w_b = w_b + s(h_a + h_b + e)/2$, yielding $\tilde{\delta} = 1/2 - e/2(h_a + h_b)$. Hence, a $\tilde{\delta}$ exists such that the Folk Theorem holds. Such value does not depend on the pay for performance scheme. When $h_a < h_b$ we have $(1 - \tilde{\delta})[w_b + s(h_a + h_b)] + \tilde{\delta}(w_b + sh_b) = w_b + s(h_a + h_b + e)/2$, yielding $\tilde{\delta} = [h_a + h_b e]/2h_a$.

Let us now consider the infinitely repeated game with relational goods (Figure 6, Appendix 2).

Under $h_a > h_b$ we get $(1 - \tilde{\delta})[w_b + s(h_a + h_b)] + \tilde{\delta}w_b = F + f + w_b + s(h_a + h_b + e)/2$ which yields $\tilde{\delta} = [h_a + h_b - e]/[2(h_a + h_b)] - (F + f)/[s(h_a + h_b)]$. When $h_a < h_b$ we have $(1 - \tilde{\delta})[w_b + s(h_a + h_b)] + \tilde{\delta}(w_b + sh_b) = F + f + w_b + s(h_a + h_b + e)/2$ yielding $\tilde{\delta} = [(h_a + h_b - e)/2h_a](F + f)/sh_a$.

Therefore the two period result is confirmed.

4.2 Firms with a vertical hierarchical structure

Remuneration schemes in firms with hierarchical structure also depend on the job levels and changes in employees compensation may be obtained through a promotion. As pointed out by Baker, Jansen and Murphy (1998), promotions have two different purposes: i) they are a way to match individuals to the job for which they are best suited and ii) they provide incentives

for lower level employees that evaluate the opportunity to increase their wage and job position obtaining a better one²⁴.

We consider here a tournament promotion system, in which the best performer is promoted to the next higher career level. We assume that, if the (s, na) equilibrium applies, the winner is randomly selected and each of the two players has a 50 percent chance of getting the promotion. The introduction of this reward system in our corporate trust game leads us to formulate the following proposition.

Proposition 7. With an individual winner tournament structure the no abuse condition never applies.

Assume that player A and player B both work at the same hierarchy level at the beginning of the game. If the trustor (player A) decides not to share his information, the payoff set is: $\{w_a + PR \mid h_a > h_b, 0 \mid h_a < h_b\}, w_b + PR \mid h_a < h_b, 0 \mid h_a > h_b, \text{Max}(h_a, h_b) - w_a + w_b + PR\}$ where PR is the promotion wage premium. If the trustor decides to share, we have to consider the (s, a) and (s, na) pairs of strategies. In the first case, the payoff set is: $\{w_a, w_b + PR, h_a + h_b - w_a + w_b + PR\}$ while, in the second case, the payoff set is $\{w_a + PR/2, w_b + PR/2, h_a + h_b + e - w_a + w_b + PR\}$. Hence, the no-abuse condition is $w_b + PR/2 > w_b + PR$ and can never hold. \square

The consequence of this result is that the trustor will never share his information when $h_a > h_b$, while he will be indifferent between doing it or not when $h_a < h_b$. We can therefore conclude that, with a promotion based incentive system and an uniperiodal game, the cooperative solution will never be reached when $h_a > h_b$. What happens if we allow for the existence of relational goods? In this case the trustor's taste for relational goods creates some room for the cooperative solution and may offset his propensity to abuse. If the trustor decides not to share the payoff set will be (respectively

²⁴As in the case of pay-for-performance remuneration systems, disadvantages and advantages of promotion based incentive schemes are widely debated. Baker, Jansen and Murphy (1998) underline how incentives generated by promotion opportunities depend on the probability of promotions and, in turn, on the identity and expected horizon of the incumbent superior. Moreover, promotion incentives: i) do not work after promotion of a young employee with a long expected horizon in the job since such promotion decreases the probability of promotion and the incentive to work hard for co-workers; ii) are reduced for employees that already obtained it; iii) are absent for employees that fall short of the promotion standard; iv) generate problems in slowly growing or shrinking firms.

for the trustor, the trustee and for the firm): $\{F + w_a + PR \mid h_a > h_b, 0 \mid h_b > h_a, F + w_b + PR \mid h_b > h_a, 0 \mid h_a > h_b, \text{Max}(h_a, h_b) - w_a + w_b + PR\}$. If the trustor decides to share the idea, the payoff set is $\{w_a, w_b + PR, h_a + h_b - w_a + w_b + PR\}$ or $\{w_a + PR/2 + F + f, w_b + PR/2 + F + f, h_a + h_b + e - w_a + w_b + PR\}$ under the (s, a) and (s, na) pairs of strategies respectively. Hence, the no-abuse condition is $F + f > PR/2$. The no abuse condition may therefore be met in presence of players taste for relational goods. This is because, even if an employee will not receive with certainty a promotion when he chooses to cooperate (the probability is 0.5), he may prefer to behave cooperatively if his taste for relational goods is strong enough.

5 Optimal personnel policies in the trust game corporation

In the light of the results presented above we may wonder what is the optimal policy for a trust game corporation which aims at maximising its output. Under the scenario in which players do not own the firm, by considering the alternatives of i) a pay for performance scheme, ii) a single winner tournament system and iii) the investment in relational goods, the third option is definitely preferred by the firm under reasonable parametric conditions. Consider the scenario of the single period full information game and assume to be in those parametric conditions $h_a > h_b, f = F = 0$ and $e < h_a + h_b$ under which the SPNE of the game is the (ns, \cdot) equilibrium and the firm output loss is, with respect to its maximum potential, $h_a + h_b + e - \text{Max}(h_a, h_b)$. In such framework the firm will find it optimal to invest in relational goods if a production technology of relational goods exists yielding the following cost function $C(f^*) = c^*$ such that $c^* < h_a + h_b + e - \text{Max}(h_a, h_b)$ (with $f^* = (h_a + h_b - e)/2 - F$ being the threshold which triggers the switch from the non cooperative to the cooperative (s, na) equilibrium in the game illustrated in section 2.1). In this perspective the trust game corporation is a productive environment in which a specific form of corporate socially responsible behaviour (the creation of a favorable environment for workers) has a positive effect on productive activity.

6 Conclusions

By modelling firm activity as a sequence of complex tasks having the basic features of trust games and requiring the contributions of different workers with nonoverlapping competencies we introduce a crucial feature of the corporate reality of our times. With this approach we explain some of the puzzles that standard firm theories cannot account for such as the lower than expected use of individual pay for performance schemes and single winner tournament schemes and the existence of corporate expenditures aimed at increasing relational goods among workers. The corporate trust game model provides several interesting insights. First, it identifies a microeconomic nexus between social capital (intended as trust) and creation of economic value at the firm level. Second, it explains why individual pay for performance schemes may, under reasonable parametric assumptions, crowd out social capital and cooperation justifying their lower than expected application in the reality. Third, it provides an explanation on why single winner tournament schemes are seldom implemented by corporations by showing how they crowd out information sharing and lead to suboptimal output, even without taking into account their potential effect on workers' intrinsic motivations. Fourth, it shows how the taste for relational goods significantly affects workers cooperation which, in turn, positively affects firm productivity. As expected, our results are much stronger in single period than in repeated games but also in the latter our conclusions hold for relevant parametric spaces and, in those cases in which cooperative equilibria may be attained on the basis of the Folk Theorem, we show that such equilibria are not renegotiation proof.

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Appendix 1

The relevance of relational goods in the workplace

We extract a sample of 82 countries from the World Value Survey and estimate the following ordered logit model to evaluate the impact of different determinants of self declared happiness ²⁵.

$$Happy_i = \alpha_0 + \alpha_1 Eqincome + \alpha_2 [Eqincome]^2 + \alpha_3 Male + \alpha_4 Mideduc + \alpha_5 Upeduc + \alpha_6 Age + \alpha_7 [Age]^2 + \alpha_8 Unempl + \alpha_9 Selfempl + \sum_{k=1} \vartheta_k Timeforrel_k + \sum_{j=1} \beta_j Drelincome_j + \sum_{i=1} \gamma_i Marstatus_i + \sum_{l=1} \delta_l Dcountry_l$$

The dependent variable ($Happy_i$) is built on the answers to the following question - *All considered you would say that you are: i) very happy; ii) pretty happy; iii) not too happy; iv) not at all happy* - by giving descending values (from 3 to zero) to answers i) to iv). *Eqincome* is a continuous measure of (income class median) equivalised income expressed in year 2000 US dollar purchasing power parities in levels and in squares. *Male* is a dummy which takes the value of one for men and zero otherwise. To measure the impact of education two dummies are included for individuals with high school diploma (*Mideduc*) and with university degree (*Upeduc*). *Age* is the respondent age (introduced in levels and in squares) to take into account nonlinearities in its relationship with happiness (see, among others, Alesina et al., 2001 and Frey and Stutzer, 2000). The professional status is measured by two different job condition variables, *Unempl* and *Selfempl*, recording unemployed and selfemployed individuals respectively. *Timeforrel* is a vector including a series of variables measuring the time spent: i) with friends (*timefriends*); ii) with working colleagues outside the workplace (*timejobfriends*); iii) with the family (*timefamily*) iv) in the worship place (parish, mosque, synagogue) with friends sharing the same

²⁵Reliability of self-declared happiness data is supported by Alesina et al. (2001) when they recall that psychologists, whose core professional activity is studying well being, extensively use these data. Alesina et al. (2001) also observe that there exists a well documented evidence of a positive correlation between self declared happiness and healthy physical reactions such as smiling attitudes (Pavot 1991, Ekman et al., 1990), heart rate and blood pressure responses to stress (Shedler, Mayman and Manis, 1993), electroencephalogram measures of prefrontal brain activity (Sutton and Davidson, 1997) and of a negative correlation between the same variable and the attitude to commit suicide (Koivumaa-Honkanen et al., 2001)

religious confession (*timerelig*); v) in clubs or volunteering (sport, culture, etc.) association (*timesportfriend*). For each of these questions the answers can be: i) every week; ii) once or twice a month; iii) a few times per year; iv) never. The difference among intensity modes is not continuous and we rank each of the answers on a scale with values which are increasing in the time spent for relationship (i.e., 3 if the answer is every week and 0 if it is never). ²⁶The relative income effect is calculated by introducing nine dummies (*Drelincome*) measuring individual position in the relevant domestic income decile. The four marital status (*Marstatus*) variables (*Single*, *Married*, *Divorced* and *Separated*) are all dummies taking the value of one if the individual has the given status and zero otherwise. Country dummies are also included. Table A.2 in the Appendix 2) reports coefficient magnitude and significance of the *timeforrel* variables in subsample estimates (males, females, high income OECD countries, low income OECD countries, European Union) showing the significance of relational time spent with job colleagues on individual happiness in the subsample of male, European Union and high income OECD countries.

²⁶By looking at the relationship between our indicator and the likely number of times per month spent in relationship which can be inferred from sample answers we figure out that our scale risk to flatten the actual frequency of the time spent in relationship. A robustness check in which we attribute an approximate per month frequency and use the value of 4, 1.5 and .3 for the “every week”, “once or twice in a month” and “a few times per year” answers respectively, shows that our findings are substantially unaltered. Results are omitted for reasons of space and available upon request.

Appendix 2

FIGURE 1 THE UNIPERIODAL FULL INFORMATION GAME

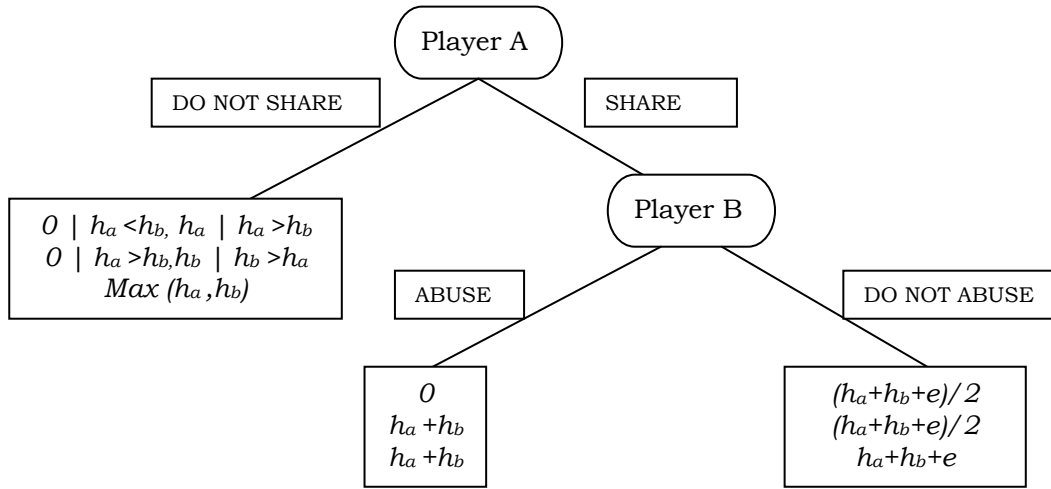


FIGURE 2 THE UNIPERIODAL FULL INFORMATION GAME WITH RELATIONAL GOODS

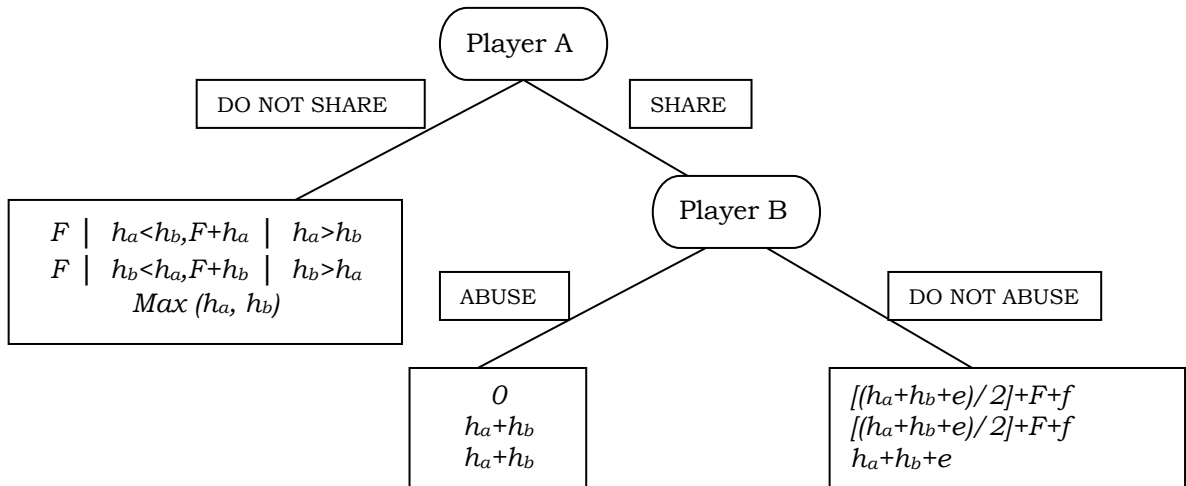


FIGURE 3 THE UNIPERIODAL FULL INFORMATION GAME UNDER IMPERFECT INFORMATION ON TRUSTEE
RELATIONAL PREFERENCES

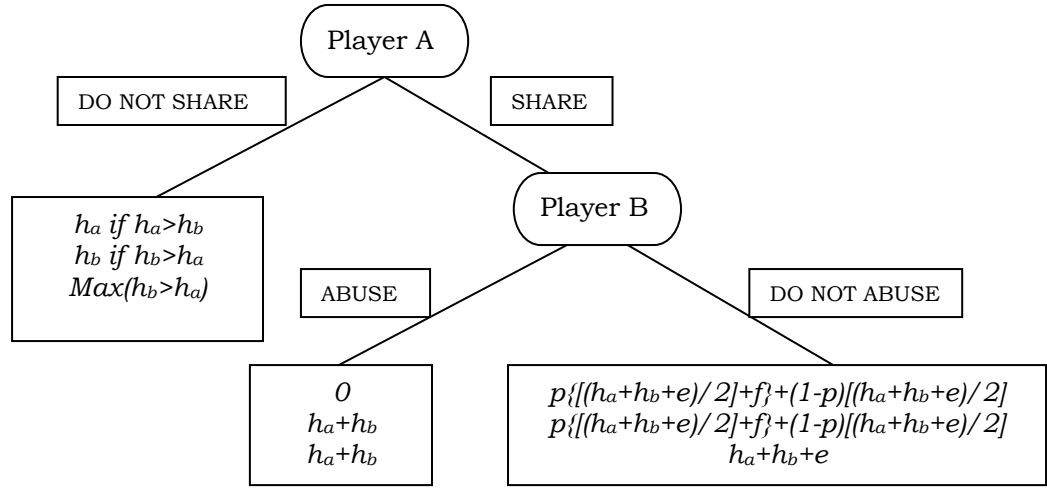
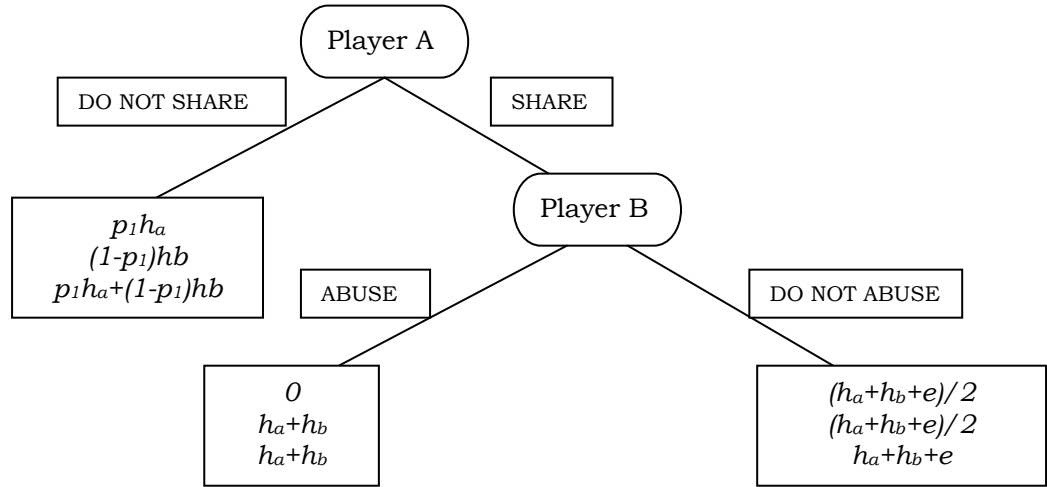


FIGURE 4 THE UNIPERIODAL FULL INFORMATION GAME UNDER IMPERFECT INFORMATION ON PLAYERS STAND
ALONE CONTRIBUTIONS

Player A's point of view



Player B's point of view

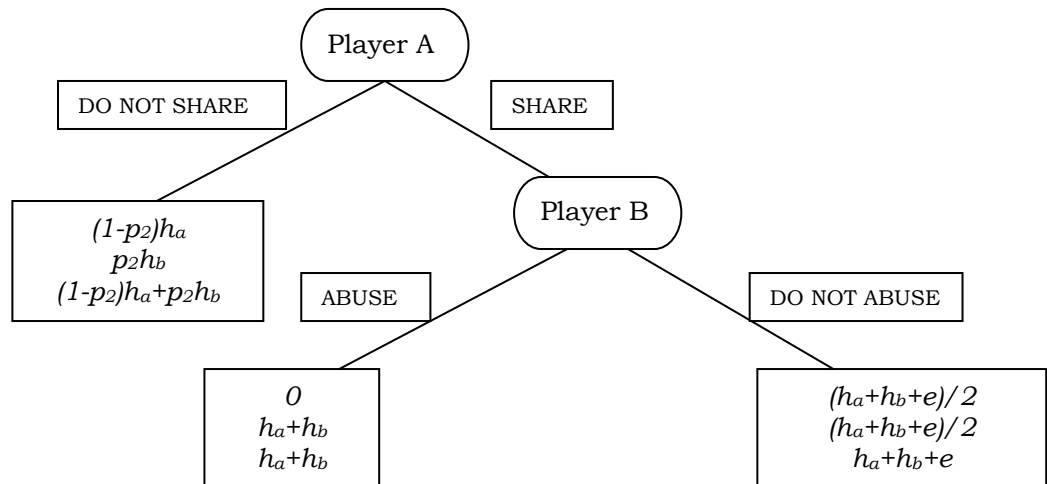


FIGURE 5: THE UNIPERIODAL FULL INFORMATION GAME WITH PAY FOR PERFORMANCE SCHEMES

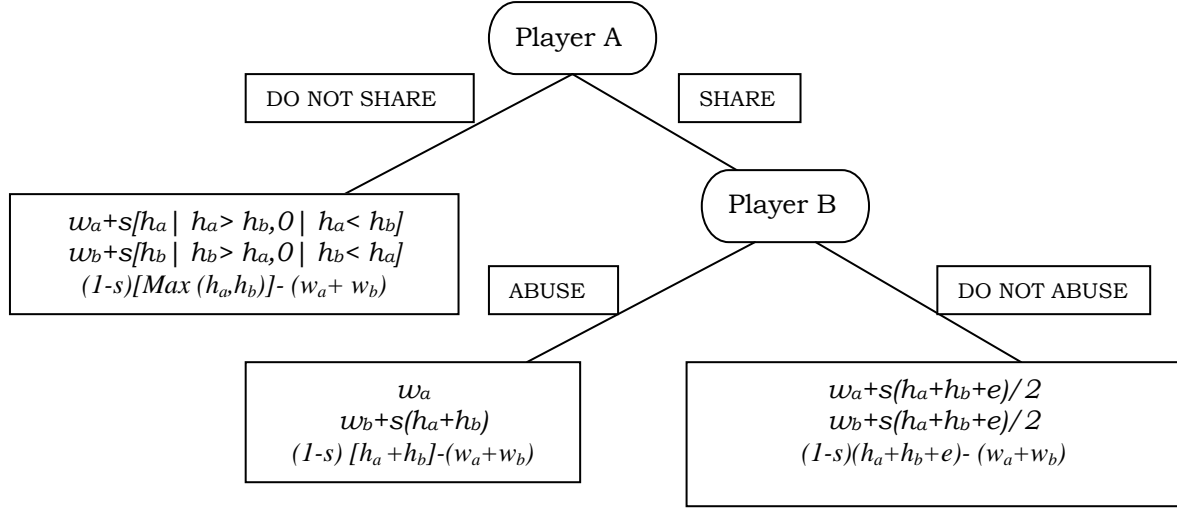


FIGURE 6: THE UNIPERIODAL FULL INFORMATION GAME WITH RELATIONAL GOODS AND PAY FOR PERFORMANCE SCHEMES

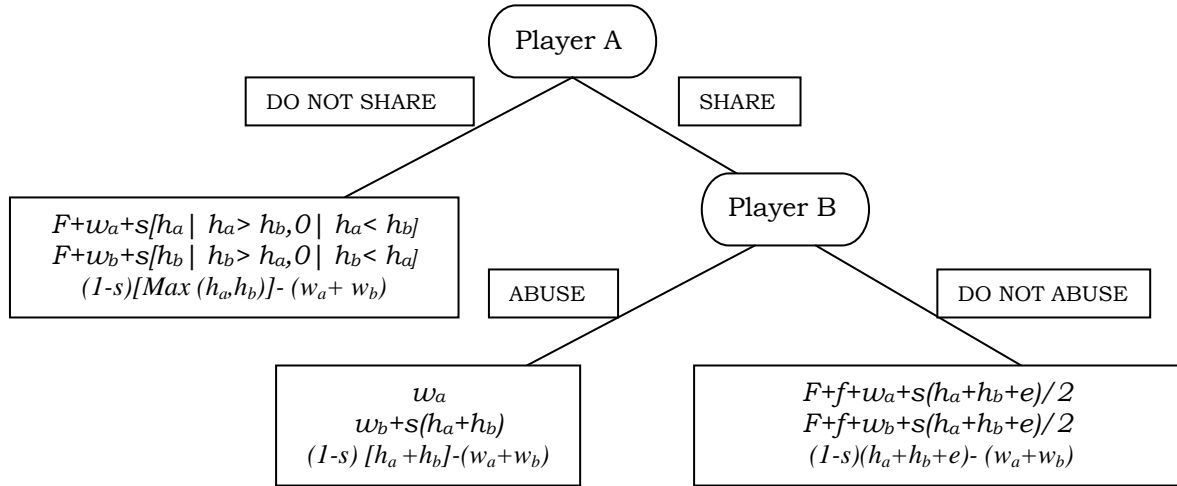
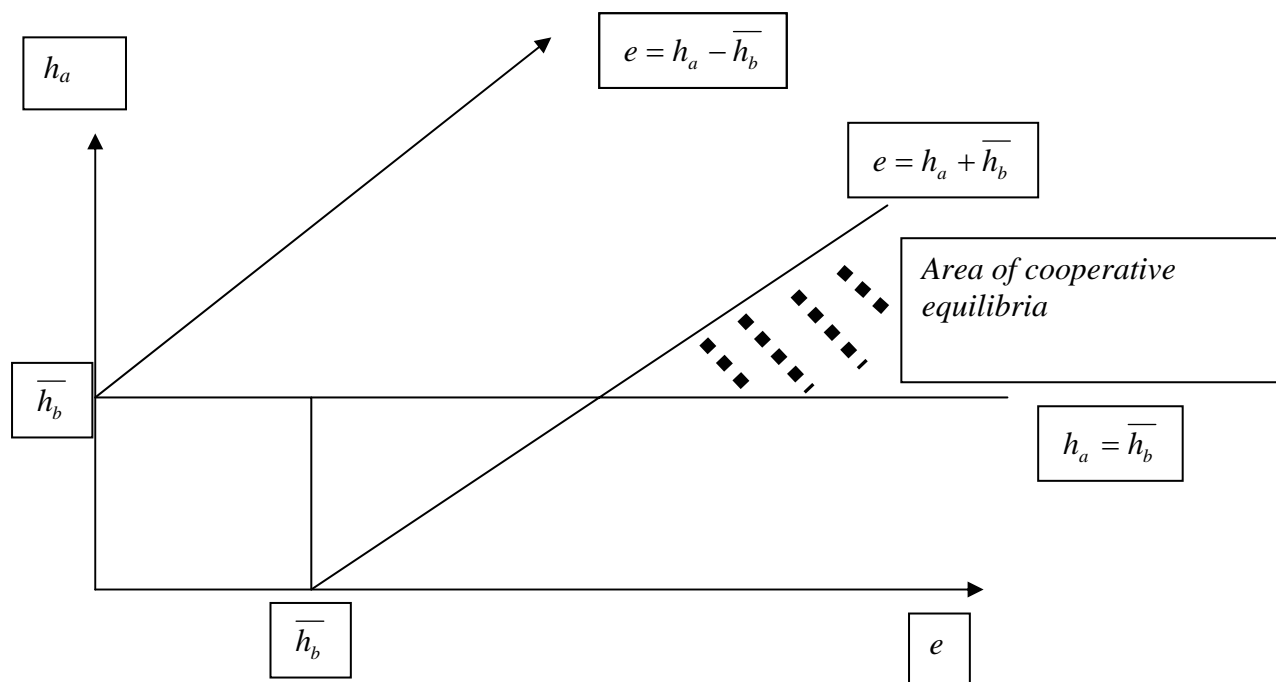


Table A2. The effect of relational time on happiness

Comp. Averleisuredue	Male	Female	Hi- oecd	NoHi- oecd	European Union
<i>Timefriends</i>	0.052** [0.023]	0.053** [0.021]	0.162** [0.048]	0.042** [0.016]	0.056 [0.113]
<i>Timejobfriends</i>	0.047** [0.016]	-0.009 [0.016]	0.07** [0.032]	0.013 [0.012]	0.169** [0.077]
<i>Timefamily</i>	0.055** [0.022]	0.055 [0.022]	0.08** [0.039]	0.051** [0.017]	0.055 [0.113]
<i>Timereelig</i>	0.138** [0.017]	0.113** [0.016]	0.155** [0.031]	0.107** [0.012]	0.135 [0.078]
<i>Timesportfriends</i>	0.065** [0.017]	0.058 [0.019]	0.088** [0.03]	0.057** [0.014]	0.14 [0.078]

GRAPHIC 1. A GRAPHICAL DESCRIPTION OF PLAYERS' PAYOFFS IN THE UNIPERIODAL FULL INFORMATION GAME
(FOR A GIVEN \bar{h}_b LEVEL)



GRAPHIC 2. A GRAPHICAL DESCRIPTION OF PLAYERS' PAYOFFS IN THE UNIPERIODAL FULL INFORMATION GAME
WITH RELATIONAL GOODS (FOR A GIVEN h_b LEVEL)

